Invertebrate Cave Fauna of Jenolan

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The invertebrate fauna known from within the caves at Jenolan is inventoried and summarised. At least 136 individual taxa have been identified although less than one-half (43%) are assigned to described species, the rest are either undescribed (8%) or have only been identified to genus level (31%) or higher taxa (18%). The collected fauna is dominated by arachnids (47%) and collembolans (24%) followed by insects (15%) and crustaceans (6%) with three or fewer taxa identified in each of the remaining groups comprising molluscs, diplopods, chilopods, annelids, platyhelminths and nematodes. In terms of ecological dependence on caves, 53% of collected taxa comprised typically epigean species with the remainder considered to be habitual cave-dwellers. Eight species (revised from 14 previously) are considered to be obligate hypogean species (terrestrial troglobites or aquatic stygobites) comprising three species of springtail, two spiders, a pseudoscorpion and two aquatic crustaceans. The diversity of troglobite species is fairly typical for karst areas in the eastern highlands of NSW but higher unrecorded diversity of stygobite species is predicted. While the invertebrate cave fauna of Jenolan has received more attention from biologists than any other karst area in NSW, substantial knowledge gaps remain. Research and conservation priorities are: (1) identify existing collections and describe new species, focussing on troglomorphic taxa which are likely to be locally endemic and of conservation significance; (2) targeted field surveys for rare troglomorphic taxa which are under-represented in existing collections; (3) sample for aquatic micro-crustacea and other stygofauna in vadose zone, phreatic zone and interstitial habitats; (4) sample for troglobites in meso-cavern and other cryptic terrestrial habitats.

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KEYWORDS: cave fauna, Jenolan, stygobite, troglobite

INTRODUCTION

The purpose of this paper is fourfold: (1) to provide an historical inventory of the invertebrate cave fauna recorded from the Jenolan karst, which to date, has largely existed in unpublished reports; (2) to summarise the current state of taxonomic and collection knowledge; (3) to identify knowledge gaps and priorities for further research and conservation; (4) to briefly re-assess the significance of the Jenolan cave fauna in a regional and national context.

The Jenolan Caves have attracted the attention of European scientists since first being visited in the 1830s, however little attention was paid to the invertebrate fauna, either above or below ground, until guide Joseph C. Wiburd initiated collections from the 1880s until around 1903. Many of Wiburd's specimens are in the Australian Museum collections. Most specimens appear to be surface collections although two species of cave-dwelling spider (*Cycloctenus abyssinus* and *Laetesia weburdi*) described by Urquhart (1890), are historically important, being the first cave dwelling invertebrates described from New South Wales.

After Wiburd and Urquhart's pioneering efforts, further documentation of Jenolan's invertebrate cave fauna lapsed until the 1960s when collections were reinitiated by John Polesson, Barbara Dew, Elery Hamilton-Smith, Ted Lane and Aola Richards. Their efforts identified ten named species of spider, pseudoscorpion, harvestman, springtail and beetle, plus several other unidentified species of millipede, cricket and moth (Hamilton-Smith 1967).

The next era of systematic survey occurred

between 1986 and 1988, when Michael Gibian, Louise Wheeler and Graeme Smith, with further involvement from Mike Gray, Glenn Hunt, Penelope Greenslade, Mia Thurgate and Ernst Holland, sampled the fauna by hand as well as netting streams and taking samples of leaf litter and guano for Tullgren funnel extractions. These efforts increased the number of recorded taxa (most undescribed) from 26 to 67 including Jenolan's first troglobitic spiders and aquatic cave fauna (Gibian et al. 1988).

Systematic collection efforts were continued by Eberhard (1993) with emphasis on aquatic macrofauna and interstitial habitats using baits, nets and pumping methods. These collections and other previous accessible records were part of a wider survey of New South Wales cave fauna which established Jenolan as one of the better sampled karsts in the State and possessing a comparatively rich invertebrate cave fauna (Eberhard and Spate 1995). Since this last survey and inventory at Jenolan, which remains unpublished in the scientific literature, further field collection efforts have been very limited.

As is typical of invertebrate surveys, and subterranean fauna especially, the taxonomic (Linnaean) shortfall means that much of the Jenolan material remains incompletely identified, awaiting specialist attention. Some progress has however been made with descriptions of four mite species (Halliday 2001), one spider (Forster et al. 1987), one amphipod (Bradbury and Williams 1997), redescription of the Jenolan harvestman (Hunt 1992), and further identification of springtails (Greenslade 2011); descriptions of an additional four mite species are in preparation (Halliday in litt. 2013).

The survey and inventory by Eberhard and Spate (1995) informed the stance taken in a subsequent paper by Thurgate et al. (2001a) who applied the metaphor 'from rags to riches' to highlight subterranean biodiversity in New South Wales and 'dispel former erroneous perceptions of a depauperate fauna'. Since this paper was published, a great amount of field survey and taxonomic research has been undertaken in other states, mostly in Western Australia and South Australia (Eberhard et al. 2009; Guzik et al. 2011), the results of which reinforce the need and timeliness for formal documentation and reappraisal of Jenolan's cave fauna as presented herein.

DEFINITIONS

Biospeleologists classify subterranean species according to their degree of ecological association and dependence upon subterranean environments. Frequently this association is presumed or inferred, especially in the case of obligate subterranean forms, on the basis of morphological modifications, typically a reduction or loss of pigmentation and eyes, elongation of appendages and compensatory enhancement of non-optic sensory structures.

Accidentals: Typically surface dwelling species whose occurrence underground is incidental, having 'accidentally' wandered or fallen in, or been carried underground by sinking water (e.g. flood), gravity or air currents

Epigean: Surface dwelling

Hypogean: Subterranean

Guanophile/Guanobite: Species that are associated with the guano of cave roosting bats or birds. Species associations with guano may be facultative (guanophile) or obligate (guanobite).

Meso-cavern: Subsurface cavity generally too small for a human to enter. Underground voids in the size range 0.1-20 cm, especially in karst and volcanic substrates. cf. macro-cavern which are voids > 20 cm, especially caves large enough for human entry.

Stygophile/Stygobite: Terms equivalent to troglophile and troglobite for aquatic cave fauna

Trogloxene: Species that habitually occupy caves for a part of their life cycle but frequently return to the surface for food. e.g. bats and cave crickets.

Troglophile: Species that can complete their whole life cycle in hypogean environments but populations of the same species also occur in epigean environments. They usually do not possess typical morphological modifications, but in some cases the cave-dwelling populations may show some degree of modification (e.g. lighter pigmentation or reduced eye size) compared to their surface-dwelling conspecifics.

Troglobite: Species that are obligate cave dwellers and entirely restricted to the subterranean environment and showing typical troglomorphic traits (see next).

Troglomorphy: Any morphological, physiological, or behavioural feature that characterizes subterranean fauna. Common morphological traits include: reduction of eyes, pigment, wings; elongation of appendages; specialization of non-optic sensory structures.

OVERVIEW

An overview of the systematic composition and current state of taxonomic knowledge appears in Fig. 1 and Table 1 and a more comprehensive list of the faunal records and the location of specimens is in the appendix. At least 136 individual taxa have so far been collected within the caves at Jenolan. In terms of recorded diversity, the collected invertebrate fauna is dominated by arachnids (47%) and collembolans (24%) followed by insects (15%) and crustaceans (6%) with three or fewer taxa identified in each of the remaining groups comprising molluscs, diplopods, chilopods, annelids, platyhelminths and nematodes (Fig. 1).

Springtails (Collembola) were very abundant and diverse with 33 recognised taxa including three troglobites and seven undescribed species (Table 1). Although a naturally diverse group, their disproportionate representation in Jenolan cave collections partly reflects the survey and identification efforts applied to this group by Greenslade (2002) and which contrasts with most of the insect groups excepting the beetles (Coleoptera) which are reasonably well known. The arachnid collections are dominated by terrestrial mites (Acarina) and spiders (Araneae) with 28 and 31 recognised taxa respectively. This also partly reflects the survey and identification efforts for these groups applied by Halliday (2001) and Gray (1973) respectively. While eight crustacean taxa have been recorded to date, this is likely to under-represent the actual diversity because this group is typically diverse in karst groundwater. Moreover, Jenolan's deep groundwater habitats have been poorly sampled for aquatic micro-crustacea. In terms of taxonomic resolution, less than one-half (59 species, 43%) of the 136 taxa are currently assigned to described species, the rest are either undescribed (11 species, 8%) or have only been identified to genus level (42 taxa, 31%) or higher (24 taxa, 18%) (Table 1).

A systematic list of all invertebrate taxa recorded from inside caves at Jenolan is given in the appendix. In terms of ecological classification, many of the taxa are considered to be 'accidental' or incidental hypogean fauna (72 taxa), falling into caves or being washed in by flood events. Forty-nine (49) taxa are considered to be troglophiles (or stygophiles). Only

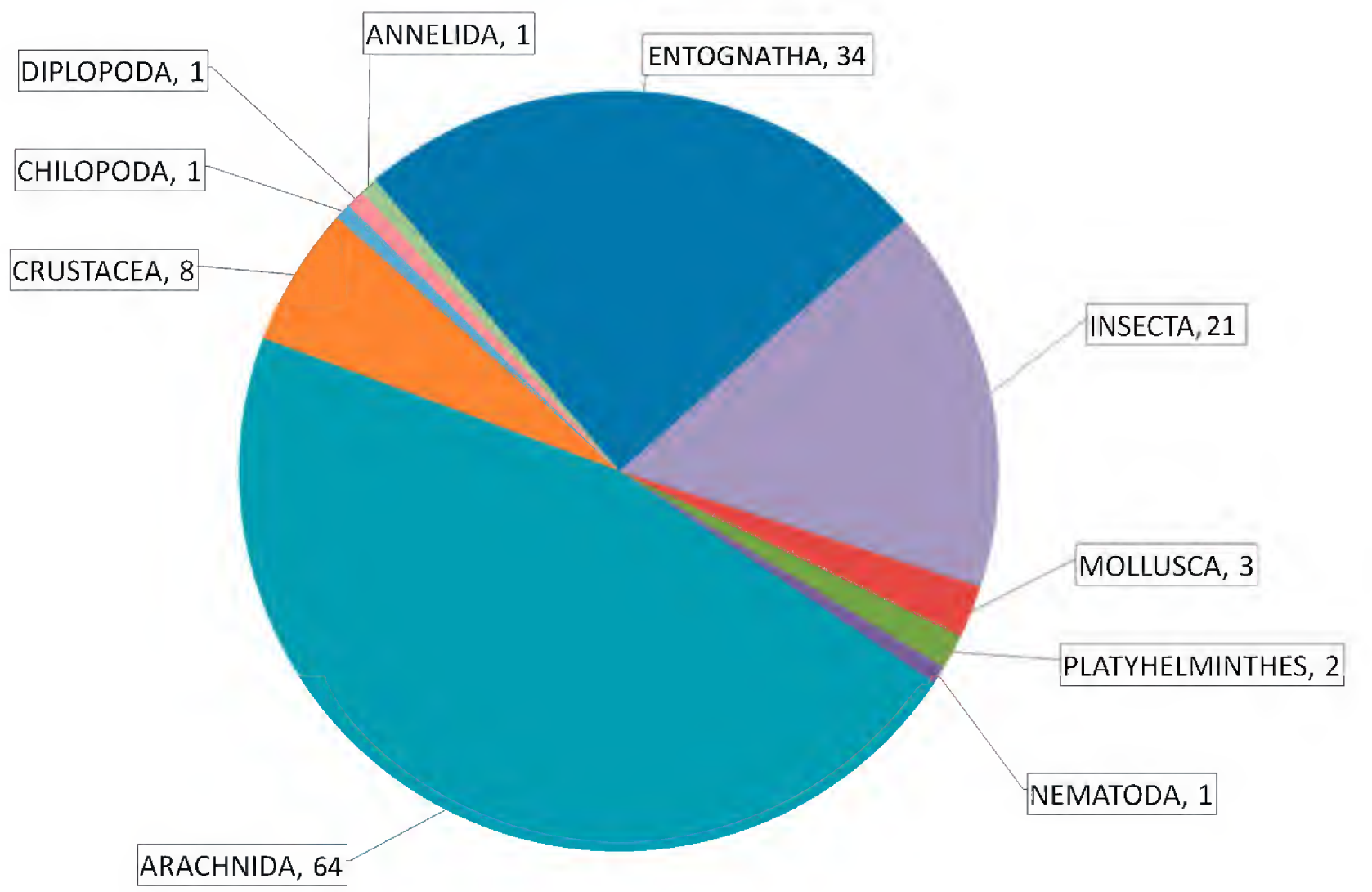

Figure 1. Systematic composition of Jenolan invertebrate cave fauna collections showing the number of taxa identified in major taxonomic groups.

Table 1. Overview of recorded diversity and taxonomic resolution in major selected groups of Jenolan cave invertebrates.

Higher Group	No. taxa	Described sp.	Undescribed n. sp.	Identified to genus	Not identified to genus	Troglobites / stygobites
Entognatha: Collembola	33	10	3	19	1	3
Entognatha: Other	1				1	
Insecta: Coleoptera	6	6				
Insecta: Others	15	2		5	8	
Arachnida: Araneae	31	12	3	13	3	2
Arachnida: Acarina	28	19	4	1	4	
Arachnida: Others	5	3		2		1
Crustacea	8	4	1	2	1	2
Diplopoda	1				1	
Chilopoda	1				1	
Mollusca	3	3				
Annelida	1				1	
Nematoda	1				1	
Platyhelmin-thes	2				2	
Totals	**136**	**59**	**11**	**42**	**24**	**8**

eight species are considered to be troglobites or stygobites, comprising three species of springtail, two spiders, a pseudoscorpion, and two crustaceans (Table 1, Figs 2, 3 and 4).

DETAILED SYSTEMATIC ACCOUNT WITH NOTES ON COLLECTIONS AND ECOLOGY

ENTOGNATHA

Subclass Collembola

Penelope Greenslade has tentatively identified 33 taxa from 11 families from material predominantly collected by Gibian, Smith, Wheeler, and Eberhard (Greenslade 2002). Collembola were mainly collected by hand from the surface of pools, from rock walls, stalagmites and other surfaces, but some Tullgren funnel extractions were taken of guano and flood debris, and some pitfall traps baited with arthropod remains. Collembola were observed to be very abundant on moist surfaces (e.g. stalagmites) in the humid and dark sections of caves developed for tourism (e.g. Orient Cave upper levels) (S. Eberhard personal observation, 1993). It is hypothesised that tourism activities have altered the ecology of these otherwise normally dark and energy-poor deep zone environments, via the introduction of artificial light and nutrients with associated growth of fungi and lampen-flora which provide a food source for grazing invertebrates to colonise deep zone habitats that would normally preclude them.

The most abundant species (*Onychiurus* sp. *fimetarius* group, *Ceratophysella* spp. *Mesophorura* sp. *krausbaueri* group and *Folsomia candida* (Willem, 1902)) also occur in Europe and are almost certainly introduced to Australia. The undescribed native *Adelphoderia* sp. was the most frequently occurring

Figure 2 (left). Scanning electron micrograph of *Adelphoderia* sp., < 1 mm (Penelope Greenslade)

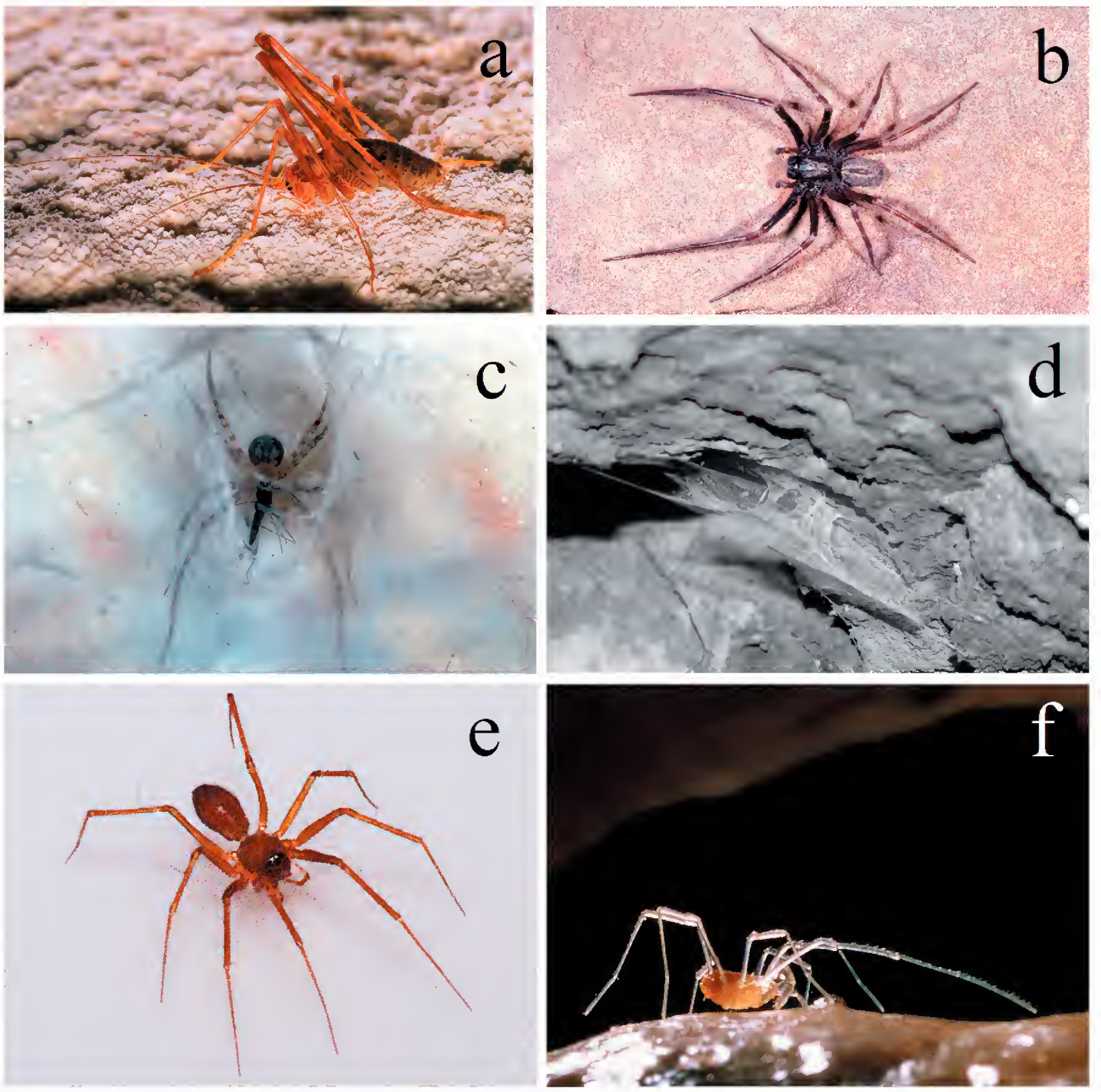

Figure 3 (below). Examples of Jenolan cave fauna, approximate length (including legs) indicated (photographer). a. *Cavernotettix* cave cricket, 25 mm (Stefan Eberhard); b. *Badumna socialis* 16 mm (Mike Gray); c. *Stiphidion facetum* (with dipteran prey), 25 mm (Stefan Eberhard); d. Web of *S. facetum* (Helen Smith); e. *Laetesia weburdi*, 5 mm (Mike Gray); f. *Holonuncia* cave harvestman, 20 mm (Stefan Eberhard).

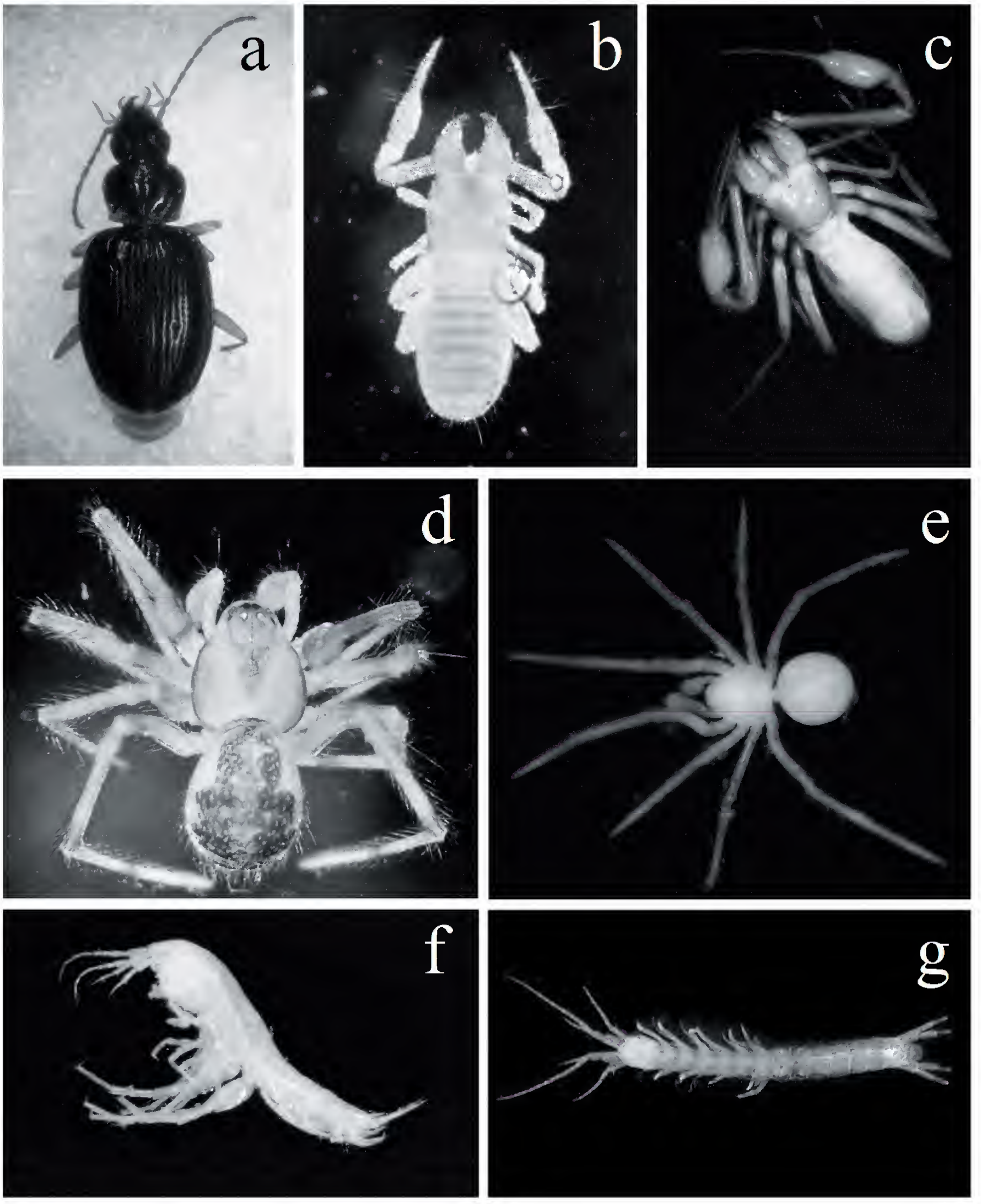

Figure 4. Examples of Jenolan cave fauna. a. *Trechimorphus diemenensis*, 5 mm; b. Pseudoscorpion *Sathrochthonius tuena*, 1.4 mm; c. Troglobitic pseudoscorpion *Pseudotyrannochthonius jonesi*, 3 mm; d. *Icona* sp., 8 mm, a troglophile with pigment and eyes; e. Troglobitic Theridiidae sp. (previously as *Icona* sp. 3), 3mm; f. Stygobitic amphipod *Neocrypta simoni*, 4 mm; g. Stygobitic crustacean, Psammaspididae gen. et sp. nov. 5mm (a.- f. Mike Gray; g. Peter Serov).

species (Fig. 2). Almost half the number of taxa were recorded only once or twice, mostly from extractions of flood debris and are almost certainly 'accidentals' washed in by flood waters. The Jenolan fauna was found to contain a greater number of genera with exotic species compared with the Tasmanian cave fauna (Greenslade 2002).

Greenslade considered that four of the Jenolan species were likely troglobites and another 10 species probable troglophiles. The troglobitic species of most interest from conservation and phylogenetic points of view (*Kenyura* sp.) is known, to date, only from a single cave. With the exception of *Coecobrya communis* (Chen and Christensen 1997) (an exotic introduced species previously incorrectly identified as *Lepidosinella armata*), none of these species has yet been described. *Coecobrya communis* was later reported by Chen et al (2005) to also occur in worm beds and is therefore considered in this work as a troglophile rather than a troglobite. Within the Jenolan Caves it has been collected from drains and gutters and on stalagmite.

All troglobitic Collembola, except *Adelphoderia* sp., were rare in the collections. *Kenyura* sp. was collected from mud banks and the surface of muddy pools; *Oncopodura* sp. from stalagmite, the surface of pools and from mud banks and *Arrhopalites* sp. from guano, although it may also be an exotic introduction (Greenslade in litt.). *Adelphoderia* sp. has been taken from stalagmite, the surface of pools, mud banks, flowstone, fungi, guano (1 record) and pitfall (one record). It was first collected by Hamilton-Smith around 1964 and was still present in 1988 surveys despite living in areas which are regularly cleaned and subject to high tourist visitation. It may be parthenogenetic as no males have been collected.

Greenslade considered the troglobitic species as the most important from a conservation standpoint and the collection sites of most importance as Mammoth, Orient and Imperial Caves (albeit probably biased by relative collecting effort).

INSECTA

Specimens belonging to the Blattodea, Orthoptera, Diptera, Lepidoptera, Hymenoptera and Psocoptera were deposited in the Entomology collections of the Australian Museum, however they do not appear to have been registered in the museum data base.

Order Coleoptera

At least seven beetle taxa belonging to four families were collected from caves. The carabid beetles were examined by Dr Barry Moore (then CSIRO) who identified three species, the most common being *Trechimorphus diemenensis* (Bates, 1878) (Fig. 4a). This species is widespread in southeast Australia, however cave forms possess shorter wings than surface forms (Moore 1964). The second species (*Meonis convexus* Sloane, 1900) has also been found in the nearby Tuglow Caves and is possibly troglophilic. The third species *Prosopogmus namoyensis* Sloane, 1895 is considered to be accidental. The pselaphid beetle *Tyromorphus speciosus* (King, 1865) was recorded by Hamilton-Smith (1966) from the Southern Limestone at Jenolan (and from caves in Victoria and Queensland). Several other pselaphids were collected by Gibian et al. (1988) which probably belong to this species, but this has not yet been confirmed. The introduced ptinine 'spider' beetle *Ptinus exulans* Erichson, 1842 has been reported from Jenolan (Hamilton-Smith 1967) as well as many other caves in most Australian states. The staphylinid beetle *Myotyphlus jansoni* (Matthews, 1878) was also reported by Hamilton-Smith (1967) in association with bat guano.

Other unidentified beetles or their larvae have been collected in Imperial, Mammoth, McKeowns Hole, Devil's Coach House and Hennings Cave.

Order Orthoptera

Cave crickets (*Cavernotettix* sp.) are commonly encountered trogloxenes in the entrance, twilight and transition zones of caves (Fig. 3a). The species from Jenolan is closely related to those from other karsts in the region but remains undescribed.

Order Hemiptera

Dr Lionel Hill examined the material collected, noting some root feeding Coccoidea, one lygaeid nymph and two species of the dipsocoroid genus *Ceratocombus*. One may be *C. australiensis* Gross, 1950 but the other is undescribed. Both also occur on leaf litter in epigean habitats and are therefore regarded as troglophiles.

Order Diptera

Diptera collected or reported include sciarids (*Chaetosciara* sp. and *Corynoptera* sp.), tipulids and chironomids. They have not been identified and all are considered to be accidental or trogloxenes.

Order Lepidoptera

The guanophilic tineid moths *Monopis crocicapitella* (Clemens, 1859) and *Hofmannophila pseudosprettella* (Stainton, 1849) have been reported from within the caves associated with bat guano. Hamilton-Smith (1967) reported that *Monopis* sp.

moths have been "found in almost all bat-inhabited caves of eastern Australia, where the larvae develop on heaps of guano". Both species of moth are cosmopolitan.

Order Hymenoptera

Ants collected in Hennings and Mammoth Caves remain unidentified.

Order Psocoptera

Booklice have been collected from detritus and guano in Mammoth, McKeowns Hole and Arch Caves. One cosmopolitan psocid (*Psyllipsocus ramburii* Selys-Longchamps, 1872) has been reported from many caves in Australia (Smithers 1964) as well as other situations and is considered to be a troglophile. The Jenolan material has not yet been identified.

ARACHNIDA

Order Acarina

Numerous mites belonging to four orders were collected both in and around the caves at Jenolan by Gibian et al., Eberhard and Holm. At least twenty-three mesostigmatid taxa (including Uropodina) were collected within the caves either in leaf litter accumulations or bat guano. Dr Bruce Halliday (2001) has published his findings on the Jenolan Mesostigmata (excluding Uropodina) and has provided preliminary information on a paper currently in preparation on the Uropodina. A single parasitic tick extracted from guano in Paradox Cave has been identified (considered to be a reptile parasite) but the remaining Jenolan mite fauna has not been further examined. This includes mites from three families of the suborder Prostigmata found in low numbers in various caves. Oribatids were present in most samples and were sometimes abundant. No work has been done on these two suborders at Jenolan.

Most of the mites collected are also known from surface habitats. Four species have been described from the Jenolan cave material (Halliday 2001) and descriptions of a further four Uropodina species are pending (Halliday in litt. 2013). None of the mites described displayed morphology associated with adaptations to subterranean life. We have tentatively classified about half of the recorded taxa as troglophiles on the basis of their being recorded, to date, only from within the caves or having been recorded in caves on several occasions, even though some are also well known from surface habitats.

Order Araneae

Spiders are the most commonly seen arachnids in surface and cave habitats at Jenolan. The best known species is the troglophilic 'social spider', *Badumna socialis* (Rainbow, 1905) (Desidae, Fig. 3b), whose sheet webs are common on the roof and walls of Jenolan's Grand Arch through which the road passes. Their web density can be so great that individual webs merge to form a single large sheet, punctured by the entrance holes of each spider. Clumps of web periodically fall off the roof, and it was suggested that dust and chemical pollution from vehicles might be adversely affecting the population (James et al. 1990). While it was found that the webs were highly polluted by lead from vehicle exhaust fumes (Hose et al. 2002), direct effects on the spider population were not demonstrated, but continuing monitoring of the arch population was recommended. The species is also found in arch habitats at Colong, Abercrombie and Wombeyan. Few are seen in caves beyond the cave arch and entrance regions, where local air currents (and night lighting) probably bring in a steady supply of insect food. The genetic relationships between the different arch populations, and a close surface relative, *Badumna longinqua* (Koch, 1867) need testing to properly assess their taxonomic and conservation status. A limited protein electrophoretic study (Gray, unpublished) showed phylogeographic differentiation between the Jenolan and Wombeyan populations. *Stiphidion facetum* Simon, 1902, a widely distributed surface species, is also commonly seen in hammock-like sheet webs on the walls of the Grand Arch (Figs 3c and 3d).

The first spider described from Jenolan Caves was the troglophilic linyphiid, *Laetesia weburdi* named for the Head Guide, Joseph Wiburd (name misspelt by Urquhart). *Laetesia weburdi* (Fig. 3e) is a relatively small spider with slender legs and variable pigmentation (dark to pale). It is found in small sheet webs suspended from walls and formation. The species was originally placed in genus *Linyphia*, but in reassigning this species to *Laetesia,* van Helsdingen (1972) noted its close similarity to species from cave and surface habitats in south west Australia, notably, *L. mollita* Simon, 1908 (the type species of the genus). A second linyphiid, as yet undescribed, is a troglobitic species, lacking both pigment and eyes. It is smaller and much rarer than *L. weburdi* and is known only from one male (in poor condition) and juveniles. The webs are similar to those of *L. weburdi* and were associated with moist formation in Imperial and River Caves. Recent searching has so far failed to find the additional material necessary to properly describe the species.

An interesting group of theridiid spiders are tentatively placed in the genus *Icona*, otherwise only known from the subantarctic islands of New Zealand (Forster 1955a and 1964). They were originally

placed in *Steatoda* (in Gray 1973), and subsequently reassigned to 'in or near' *Icona* following examination by H.W. Levi (pers. comm.). These spiders, currently undescribed, are distributed across southern Australia as troglophilic and troglobitic species. At Jenolan there is at least one unidentified species of this group (Fig. 4d), a relatively common troglophile with varying degrees of depigmentation (it was at first thought to represent two species). These troglophiles were described as having "scatty webs over mud or leaf litter deposits" (Gibian et al. 1988).

A small troglobitic species of theridiid from Hennings Cave (Fig. 4e) was also previously included under *Icona* (in Gibian et al. 1988, Eberhard and Spate 1995). The taxonomic placement of this eyeless and totally depigmented species must wait until adult specimens are available.

A troglophilic species of *Cryptachaea* is widely distributed in south-eastern Australia: *C. gigantipes* (Keyserling, 1890) is recorded from a number of NSW caves (Smith et al. 2012), including Jenolan (previously as *Achaearanea veruculata* (Urquhart, 1885) in Gibian et al. 1988, Eberhard and Spate 1995). This large species makes a typical theridiid 'gumfoot' capture web.

Like the linyphiids, the other web building troglophiles are very small. These include members of two surface litter dwelling families: Micropholcommatidae (0.5-1.5 mm) spiders found on mud banks, in litter debris and in small webs on stalagmites; Mysmenidae (up to 2 mm) where a male was taken from a 'small web'. On close examination these webs are usually seen to be modified orb webs.

Small theridiosomatid spiders (*Baalzebub* sp.) are often seen in cave entrance, twilight and transition zones in their distinctive cone-shaped orb webs. These spiders use a central tension line to maintain this web shape; they release the tension when prey approaches allowing the sticky orb web to rebound over it.

The non web-building spider fauna includes several vagrant troglophilic hunters often associated with loose rock, soil bank, guano deposit, litter detritus and root mass habitats. Most belong to genera endemic to Australia and New Zealand. *Cycloctenus abyssinus* (family Cycloctenidae) has been periodically recorded in cave habitats. The original description (by Urquhart 1890) was of a female and subadult males; Rainbow (1893) described an adult male and referred to several female specimens, but the whereabouts of these are unknown, and today there are no pre-1900 specimens or males currently recorded in the Australian Museum collections. These spiders are well pigmented and have large eyes and are probably conspecific with a surface species. The spiders are not often seen, but are probably an important predator in the caves ecosystem.

Kaiya terama Gray, 1987 (Gradungulidae) has been found in several caves at Jenolan, and is a common epigean log and litter dwelling species.

Tasmanoonops spp. (Orsolobidae) are much smaller spiders that are found in similar surface habitats. They have been collected in Elder and Hennings caves associated with moist habitats, including hanging root masses.

Order Opiliones

One troglophilic species, the triaenonychid *Holonuncia cavernicola* (Fig. 3f) was originally described from "Jenolan Caves" (Forster 1955b) and re-described by Hunt (1992) based on the holotype and additional material collected by Gibian et al. (1988), Hunt and others. While the species regularly occurs in caves at Jenolan, specimens are also found in epigean habitats. The harvestman in caves at Tuglow is tentatively assigned to *H. cavernicola*. Other species in the genus *Holonuncia* are found within multiple karsts in southern New South Wales. Pigmentation and eye size varied between cave and surface populations but also within cave populations (Hunt 1992).

A second species of harvestman, the neopilionid *Megalopsalis* sp. is known from two specimens collected from the entrance chamber of Mammoth Cave and is probably accidental in caves.

Order Pseudoscorpiones

Three species have been collected at Jenolan. One is probably an accidental; the other two were described by Chamberlin (1962) with only vague locality data but have since been confirmed to occur at Jenolan. *Sathrochthonius tuena* (Fig. 4b) is a guanophile from Bow and Paradox Caves as well as from Wombeyan Caves. The other is a troglobite, *Pseudotyrannochthonius jonesi* (Fig. 4c) known from Imperial Cave and the Chevalier extension.

MYRIAPODA

Order Geophilomorpha

A geophilomorph centipede seen on flowstone in Hennings may be an accidental.

Order Polydesmida

Polydesmid millipedes collected from several caves are considered to be troglophiles. No further work has been carried out.

CRUSTACEA

Gibian et al. (1988) recorded the first aquatic cave fauna from Jenolan, reporting amphipods (Crangonyctidae), copepods (Harpacticoida, Cyclopoida) and ostracods. This material, augmented by the more extensive collections of Eberhard (1993), has been re-examined and some identifications amended to at least six aquatic taxa.

Order Cyclopoida

At least two, possibly three, species of copepod have been collected in Mammoth and Lucas caves. The two species that have been identified are well known surface copepods and may be accidentals or stygophiles. The third putative species remains unidentified.

Order Isopoda

Two species of terrestrial oniscid slaters have been collected, one strongly pigmented and eyed from Elder Cave, the other is a single weakly pigmented specimen (*Styloniscus* sp.) from Mammoth Cave. We have been unable to locate the Elder Cave specimen and the *Styloniscus* specimen has not been further studied.

One species of aquatic phreatoicoid isopod (*Crenoicus* sp.) has been netted in both the Imperial resurgence and in Paradox Cave by Eberhard. It is likely stygophilic but has not been further studied.

Order Amphipoda

Eberhard trapped the eusirid amphipod *Pseudomoera fontana* (Sayce, 1902) in both the Northern Stream sink and the Imperial Cave resurgence; it is a common species in southeast Australian streams and is either an accidental or stygophile.

Neoniphargid amphipods were trapped in both Paradox Cave and the Imperial streamway. Bradbury and Williams (1997) described the stygobitic *Neocrypta simoni* based on the material collected by Stefan Eberhard in Paradox Cave (Fig. 4f); five specimens netted in the Imperial River by Gibian, Smith and Wheeler have not been identified as yet.

Order Anaspidacea

Eberhard (1993) collected stygobitic syncarids (Psammaspididae) by placing baits (kippers in brine) in the Imperial and Spider Cave rivers and in perched seepage fed pools well above the river level. Mia Thurgate collected more from the Pool of Reflections in River Cave in 2000. Psammaspidids (Fig. 4g) are a primitive group of eyeless crustaceans recorded from ground waters in eastern Australia. No further taxonomic work has been conducted on this interesting material.

MOLLUSCA

Class Gastropoda

Pommerhelix depressa (Hedley, 1901) and *Elsothera sericatula* (Pfeiffer, 1849) have been collected in Casteret Cave and caves in the southern limestone. Eberhard collected the aquatic snail *Glacidorbis hedleyi* Iredale, 1943 at the Imperial resurgence. Snails collected by Gibian et al. (1988) have not been examined.

ANNELIDA

Terrestrial and aquatic oligochaetes were reported by Gibian et al. (1988) and Eberhard (1993) but not further identified.

NEMATODA

Terrestrial and aquatic nematodes were reported by Gibian et al. (1988) and Eberhard (1993) but not further identified.

PLATYHELMINTHES

Flatworms of the Orders Paludicola and Terricola were reported by Eberhard from Wiburds Lake, Mammoth and Serpentine Caves.

DISCUSSION

Comparisons of biodiversity patterns between different karst areas can be fraught with biases including, inter alia, area effects and differences in survey effort, methods and taxonomic biases, as well as bias towards troglobitic/stygobitic species, incorrect ecological classification, provincialism and other fallacies (see Culver et al. 2013). Nevertheless we consider it timely to undertake a brief re-appraisal of Jenolan's cave fauna to place its significance in a regional and national context, especially because a great deal of subterranean fauna research has occurred elsewhere in Australia (see Guzik et al. 2011) since the previous Jenolan and New South Wales inventory by Eberhard and Spate (1995); Thurgate et al. (2001a, 2001b).

Jenolan retains its status with the highest

recorded subterranean taxonomic diversity (136 taxa) of any karst area in New South Wales, which is at least partly an artefact of high survey effort, with Jenolan drawing the attention of biologists over many decades. Notwithstanding, we hypothesise that other environmental factors may be responsible. Firstly, Jenolan is highly karstified and hosts the most extensive cave system in New South Wales with over 40km of surveyed cave passage. This subsurface 'area effect' is consistent with studies elsewhere (e.g. Graening et al. 2006) which show increasing cave length correlates with increasing species richness. Secondly, Jenolan is a topographically diverse fluvial karst with many large-sized cave entrances (vertical and horizontal) and multiple sinking streams which facilitate active colonisation of caves by animals, but also particularly, their passive transport underground (by gravity, water or air), which may partly account for the high proportion (53%) of taxa classified as 'cave accidentals' in our inventory. This ratio is not dissimilar to 42% recorded in a desktop bio-inventory of the Nullarbor which is a significantly larger karst area (by > 2 orders magnitude) but similarly characterised by multiple large-sized cave entrances where collecting efforts have historically tended to focus (Eberhard in litt.).

While the classification of taxa as 'accidentals' or otherwise (trogloxene, troglophile, troglobite) is often necessarily inferred owing to limitations in survey data and knowledge of species taxonomy and ecology, ambiguous classification or misinterpretation of troglomorphic traits may skew interpretation of site 'significance' when assessed in terms of total species richness. For this reason, many comparisons between karst areas in the literature are restricted (arguably biased) towards troglomorphic species (presumed troglobites and stygobites, see Culver and Sket (2000). Notwithstanding, troglobites and stygobites are more typically short-range endemic species and therefore more vulnerable to threats and extinction from environmental changes. On this basis a high conservation significance may be attributed to troglobites and stygobites.

In paving the way for standardized and comparable subterranean biodiversity studies, Culver et al. (2013) concluded that it is necessary to treat troglobites and stygobites differently from non-obligate species, because differences of opinion exist as to which species are troglobites and stygobites. In our opinion the eight species considered likely to be troglobites or stygobites at Jenolan (revised from 14 troglomorphic species earlier reported by Thurgate et al. 2001a) ranks as fairly typical for karst areas in the eastern highlands (Eberhard and Spate 1995). At this point in discussion it is appropriate to correct an error in the Jenolan Karst Conservation Reserve Draft Plan of Management (Department of Environment and Conservation NSW, undated, p. 49) which mistakenly reports 147 species of troglobitic [sic] fauna.

We consider it likely that additional obligate subterranean species remain to be discovered at Jenolan, especially in the poorly sampled epikarst, vadose, deep phreatic and interstitial aquatic habitats, and terrestrial meso-cavern habitats. Our prediction is based partly on the diversity known from Wombeyan Caves, located 55 kilometres south of Jenolan, which has a high diversity (11 species) of stygobitic amphipods (Bradbury and Williams 1997). For comparison, the richest obligate cave fauna recorded from eastern Australia is Bayliss Cave, a lava tube in north Queensland, with 20 species of troglobites (Culver and Sket 2000). Tasmania is also relatively diverse with 15 or more obligate species recorded from well-developed karst areas (Eberhard 1996).

The fallacy of provincialism as termed by Culver et al. (2013) occurs when data from one 'favoured' place is treated differently than data from other places. In applying the metaphor 'from rags to riches' to highlight subterranean biodiversity in New South Wales, Thurgate et al. (2001a) may have been justifiably optimistic, however, this paradigm deserves to be reappraised in the national context considering subsequent discoveries of remarkably diverse subterranean faunas in other states. Recently in Western Australia sampling of deep groundwater aquifers has revealed the existence of diverse (> 60 species) stygobite communities (e.g. Eberhard et al. 2009). Sampling of terrestrial meso-cavern habitats in iron-ore and calcrete rocks has also revealed highly diverse troglobite communities comprising > 45 obligate species (S. Eberhard in litt.).

FUTURE RESEARCH AND CONSERVATION PRIORITIES

The Jenolan Karst Conservation Reserve Draft Plan of Management (Department of Environment and Conservation NSW, undated) recognises that cave fauna is highly susceptible to disturbance and recommends further investigation into the potential impacts of human activities on the conservation of these species. The material from the 1986-1993 collections represent a reasonable baseline survey for Jenolan Caves. Nevertheless cave fauna, especially the highly adapted species, are usually rare and it is highly likely that further intensive collection efforts would result in new taxa being found. Alternative

collection techniques used for aquatic micro-fauna and terrestrial meso-cavern habitats e.g., damp leaf litter packs (Weinstein and Slaney, 1995) should be evaluated as they may effectively sample taxa that were not collected using the methods previously employed. The current state of knowledge, gaps and research priorities are summarised in Table 2.

A great deal of the material collected has not yet been sorted to species level. New species still await formal description due to the very limited funding and diminishing taxonomic resources available in Australia. Future collection efforts could concentrate on obtaining specimens of groups where a funded taxonomist is available, or aim to increase the number and quality of specimens of certain important troglobitic and stygobitic representatives (e.g. by obtaining more mature material, including both sexes) or seek information on their biology and ecology, about which virtually nothing is known.

The species of most conservation interest are those species restricted to the subterranean environment, especially the troglobites and stygobites. The physical extent and degree of karstification at Jenolan, and the hypothesised presence of undiscovered troglobitic and stygobitic taxa in the mesocavern and other cryptic aquatic habitats, emphasises the importance of the continuing biological exploration of this significant subterranean ecosystem.

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pdf files of unpublished reports denoted with asterix(*) are available from the author for correspondence

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Table 2. State of knowledge, gaps and research priorities.

Higher Group	Relative Diversity	Taxonomic Resolution	Comments	Research Priorities
Entognatha: Collembola	High	Good	Well sampled and identified, includes troglobites and undescribed n. sp.	Describe n. sp. especially troglobites
Insecta: Coleoptera	Moderate	Good	Well sampled and identified in macro-cavern habitats but meso-cavern habitats poorly sampled	Sample meso-cavern habitats
Insecta: Others	Moderate	Poor	Poor taxonomic resolution	Identify existing collections
Arachnida: Araneae	High	Good	Generally well sampled and identified, but includes rare troglobites and undescribed n. sp.	Targeted sampling of troglobites and describe n. sp.
Arachnida: Acarina	High	Good	Well sampled and identified	Describe n. sp.
Arachnida: Others	Low	Good	Well sampled and identified in macro-cavern habitats but meso-cavern habitats poorly sampled	Sample meso-cavern habitats
Crustacea	Moderate	Moderate	Poorly sampled, likely to be more diverse, especially micro-crustacea	Sample deep aquatic habitats, identify and describe n. sp.
Myriapoda	Low	Poor	Poor taxonomic resolution	Identify existing collections
Gastropoda	Low	Excellent	Terrestrial snails sampled and identified, aquatic snails poorly sampled (Hydrobiidae)	Sample deep aquatic habitats
Annelida, Nematoda, Platyhelminthes	Low	Poor	Poorly sampled, likely to be more diverse, especially aquatic Oligochaeata	Sample deep aquatic habitats

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Appendix
(next 18 pages)
Invertebrate fauna collected within the caves at Jenolan

*** Specimens identified by Dr C.B. Allen (CA), Dr M. Beier (MB), Dr J.H. Bradbury (JB), Dr C. Car (CC), Dr P. Cranston, Dr M. Gray (MG), Dr A. Green (AG), Dr P. Greenslade (PG), Dr B. Halliday (BH), Dr M. Harvey (MH), Dr L. Hill (LH), Dr G. Hunt (GH), Dr T. Karanovic (TK), Dr H.W. Levi (HL), Dr R. Mesibov (RM), Mr G. Milledge (GM), Dr B. Moore (BM), Dr E. Nielsen (EN), Dr W. Ponder (WP), Dr M. Rix (MR), Mr P. Serov (PS), Dr H. Smith (HS), Dr J. Stanisic (JS), Prof. W. Williams (WW), Dr G. Wilson (GW). Typ = type specimen(s). References to Smith as collector are G. Smith unless indicated otherwise.**

**** Native or introduced/cosmopolitan**

***** Ecological Status: Accidental (Ac), Guanophile (Gp), Stygophile (Sp), Stygobite (Sb), Troglophile (Tp), Troglobite (Tb), Trogloxene (Tx)**

****** Institutional abbreviations: Australian Museum, Sydney (AMS), American Museum of Natural History, New York (AMNH), Australian National Insect Collection, Canberra (ANIC), National Museum of New Zealand, Wellington (NMNZ), South Australian Museum, Adelaide (SAMA)**

PHYLUM or CLASS Subclass Order Family Taxa	ID. by *	N or I/C **	ES ***	Comments on identification and name	Caves	Reference(s) and/or Location of specimens ****
CLASS ENTOGNATHA						
Subclass Collembola						
Family Hypogastruridae						
Triacanthella sp.	PG	N	Tp?	Not further identifiable	Bow, Mammoth; terrestrial soil species	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Ceratophysella denticulata (Bagnall, 1941)	PG	I/C	Ac		Orient; Bow, Mammoth; cosmopolitan species very common in disturbed habitats in SE Australia; easily washed into caves	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Ceratophysella gibbosa (Bagnall, 1940)	PG	I/C	Ac		Orient; Bow, Mammoth; cosmopolitan species very common in disturbed habitats in SE Australia; easily washed into caves	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Mesogastrura libyca (Caroli, 1914)	PG	I/C	Tp		Imperial, single collection behind Lot's Wife; originally described from Tripoli and known in Europe from both terrestrial and cave habitats	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Family Oncopoduridae						
Oncopodura n.sp.	PG	N	Tb	New troglobiont so far only known from Jenolan Caves although a few specimens of *Oncopodura* from Jaunter and Bungonia are in collections	Imperial, Mammoth, Hennings, Wiburds Lake (stalagmite, surface of pools, mud bank)	Gibian et al. (1988), Thurgate et al. (2001a); Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Family Sminthuridae						
Adelphoderia n.sp.	PG	N	Tb	A troglobiont species belonging to an Australian endemic genus	Imperial, Orient, Lucas, Barralong, Chifley, Elder, Hennings, Mammoth, Paradox, Wiburds Lake (pool surfaces, mud banks, stalagmite, flowstone, fungi, guano)	Greenslade (2002); Greenslade (2011); Thurgate et al. (2001a); SAMA and/or ANIC
Arrhopalites sp.	PG	I/C?	Tp		Single specimen from Paradox; other species of genus found in caves in North America and Europe (guano)	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC

Temeritas sp.	PG	N	Ac	Not further identifiable	Mammoth; native terrestrial species; genus occurs in eucalypt forests and is associated with fungi on rotting logs	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Family Onychiuridae					
Onychiurus sp. *fimetarius* (Linnaeus) group	PG	I/C	Tp		Imperial, Orient, Mammoth, Elder, Devil's Coach House, Bow; cosmopolitan soil species, probably introduced	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Family Tullbergidae					
Mesophorura sp. *krausbaueri* Börner group	PG	I/C	Tp	Not further identifiable	Orient, Mammoth, Devil's Coach House, Serpentine, Bow; cosmopolitan terrestrial species	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Tullbergia sp.	PG	N	Tp	Not further identifiable	Orient, Bow, Mammoth, Wiburds Lake; terrestrial native soil species	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Dinaphorura sp.	PG	N	Tp	Not further identifiable	Mammoth; terrestrial native soil dwelling species	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Family Odontellidae					
Odontella sp. 1, sp. 2, sp. 3	PG	?	Ac		Bow (all 3 species from Bow)	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
gen. nov. nr *Odontella*	PG	N	Ac	Not further identifiable	Bow	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Family Neanuridae					
Neanura muscorum (Templeton, 1835)	PG	I/C	Ac		Orient, Mammoth, Bow; cosmopolitan species found in improved pasture in SE Australia	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Australonura sp. nr *meridionalis* Stach, 1951	PG	?	Tp		Mammoth, Devil's Coach House, Bow	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Undetermined Lobellini	PG	N	Tp	Not further identifiable	Mammoth, Bow; terrestrial native species	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Kenyura n.sp.	PG	N	Tb?	May belong to a new genus or to *Kenyura* which has not previously been recorded in Australia, but is known to exist in Qld and NE Tasmania; possibly true troglobite as some setae elongated	Mammoth (mud bank, surface of muddy pools)	Thurgate et al. (2001a); Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Ceratrimeria sp.	PG	?	Ac		Bow	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC

Family Neelidae						
Megalothorax sp.	PG	N	Tp	Not further identifiable	Serpentine; all species in genus live in soil and moss in humid habitats	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Family Brachystomellidae						
Brachystomella sp.	PG	?	Ac		Mammoth, Bow	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Subclavontella sp.	PG	?	Ac		Bow	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Family Entomobryidae						
Coecobrya communis (Chen and Christensen, 1997)	PG	I/C	Tp	First reported as *Lepidosinella armata* (Richards and Lane 1966). Greenslade (1992) later considered original and additional material from Orient Cave as *Coecobrya* nr *hoeffti*. Greenslade (2002) later records the species as *Sinella* (*Coecobrya*) *communis*, an exotic introduction	Orient (drain and gutter; stalagmite); also known from worm beds as well as caves overseas	Richards and Lane (1966); Thurgate et al. (2001a); Greenslade (1992); Greenslade (2002); pre-1989 specimens in NMNZ; more recent material in SAMA and/or ANIC
Lepidocyrtus sp.	PG	N?	Ac	Immature; not further identifiable	Devil's Coach House, Serpentine, Paradox; probably a native terrestrial species	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Ascocyrtus cinctus Schaeffer, 1898	PG	N	Ac		Serpentine; common, native terrestrial species with widespread distribution in forest leaf litter of SE Asia and SW Pacific	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Family Isotomidae						
Folsomia candida (Willem, 1902)	PG	I/C	Tp		Imperial, Orient, Barralong, Mammoth, Chifley, Devil's Coach House, Serpentine, Bow, Wiburds Lake, Paradox; cosmopolitan species, rare in terrestrial habitats. First described from caves in Belgium; frequently encountered in animal cultures and pot plants	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Folsomides exiguus Folsom 1932	PG	N	Ac		Bow; native terrestrial species; soils in humid forests	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Isotoma sp.	PG	?	Ac		Bow	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC

Parisotoma sp.	PG	?	Ac		Bow	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Cryptopygus caecus Wahlgren, 1906	PG	N	Ac	Initially determined as *Isotomodes* by Salmon	Guano, cave not specified; common soil and humus species in SE forests and subantarctic islands	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
cf. *Cryptopygus* sp.	PG	N	Ac	Not further identifiable	Bow; native terrestrial species	Greenslade (2002); Greenslade (2011); SAMA and/or ANIC
Order Protura						
Undetermined	PG	?	Ac		Mammoth	Gibian et al. (1988); whereabouts unknown, probably SAMA and/or ANIC
CLASS INSECTA						
Order Blattodea						
Undetermined		N	Ac			Gibian et al. (1988); whereabouts unknown, probably AMS
Order Orthoptera						
Family Rhaphidophoridae						
Cavernotettix sp.		N	Tx		Arch, Orient, Mammoth	Gibian et al. (1988); photocopied page titled Jenolan NSW 24-25 Oct 1987 (Eric Holm) probably never published; whereabouts unknown, probably AMS
Order Hemiptera						
Undetermined Coccoidea	LH	N	Ac?		Devil's Coach House (flood debris)	Gibian et al. (1988); Lionel Hill (in litt. 1989); specimens currently with LH but will be deposited in AMS
Undetermined Hemiptera						Gibian et al. (1988); whereabouts unknown, probably AMS
Family Lygaeidae						
Undetermined Rhyparochrominae	LH	N	Ac	Single nymph	Devil's Coach House (flood debris)	Lionel Hill (in litt. 1989); specimens currently with LH but will be deposited in AMS
Family Ceratocombidae						

Ceratocombus 2 spp.	LH	N	Ac	Lionel Hill (in litt. 1989) suggests one of these species may be *Ceratocombus australiensis* Gross	Mammoth, Devil's Coach House, Serpentine (surface or edges of pools, mud banks, flood debris); both species known to occur in epigean leaf litter — probably washed into caves	Lionel Hill (in litt. 1989); specimens currently with LH but will be deposited in AMS
Order Psocoptera						
Undetermined Psocoptera	GC	?	Tp?		Mammoth, McKeowns Hole, Arch (guano, litter, mud bank)	Gibian et al. (1988); whereabouts unknown, probably AMS
Order Diptera						
Undetermined flies			Ac?		Hennings, Wiburds Lake, Devil's Coach House (flood bypass), Mammoth, Serpentine, Elder, McKeowns Hole, Bow	Gibian et al. (1988); T. Moulds (in litt. 2013) whereabouts unknown, probably AMS
Family Tipulidae						
Undetermined			Ac?			Gibian et al. (1988); whereabouts unknown, probably AMS
Family Chironomidae						
Undetermined			Ac?			Gibian et al. (1988); whereabouts unknown, probably AMS
Family Sciaridae						
Chaetosciara sp.	PC	?	Ac?		Lucas (pool of water)	Photocopied page titled Jenolan NSW 24-25 Oct 1987 (Eric Holm), probably never published; whereabouts unknown, probably ANIC
Corynoptera sp.	PC	?	Ac?		Chifley (wood fragments by river)	Photocopied page titled Jenolan NSW 24-25 Oct 1987 (Eric Holm), probably never published; whereabouts unknown, probably ANIC
Undetermined sciarids		?				Gibian et al. (1988); whereabouts unknown, probably AMS
Order Hymenoptera						
Family Formicidae						
Undetermined ants			Ac?		Hennings, Mammoth	Gibian et al. (1988); whereabouts unknown, probably AMS

Order Lepidoptera					
Undetermined moths				Serpentine, Nettle, McKeowns Hole	Gibian et al. (1988); whereabouts unknown, probably AMS
Family Tineidae					
Monopis crocicapitella (Clemens, 1859)	EN	I/C	Gp	Imperial, Arch	Photocopied page titled Jenolan NSW 24-25 Oct 1987 (Eric Holm), probably never published
Family Oecophoridae					
Hofmannophila pseudosprettella (Stainton, 1849)	EN	I/C	Ac	No data	Dew (1963)
Order Coleoptera					
Undetermined beetles or larvae				Imperial, McKeowns Hole, Devil's Coach House, Hennings, Mammoth	Gibian et al. (1988); T. Moulds (in litt. 2013) whereabouts unknown, probably AMS
Family Carabidae					
Trechimorphus diemenensis (Bates, 1878)	BM	N	Tp	Mammoth (gravel, mud banks) also known from other NSW cave areas	Moore (1964); B. Moore (in litt. 1987) ANIC (?)
Meonis convexus Sloane, 1900	BM	N	Ac	Wiburds Lake, Mammoth (also known from Tuglow Caves)	B. Moore (in litt. 1987) ANIC?
Prosopogmus namoyensis Sloane, 1895	BM		Ac	Mammoth	B. Moore (in litt. 1987) ANIC?
Family Staphylinidae					
Myotyphlus jansoni (Matthews, 1878)		N	Tp	Un-named cave in Southern Limestone	Hamilton-Smith and Adams (1966); whereabouts of specimen unknown, probably in the Biospeleological Collection, SAMA
Undetermined staphylinid				Devil's Coach House (flood debris)	Gibian et al. (1988); whereabouts unknown, probably AMS
Family Anobiidae					
Ptinus exulans Erichson, 1842		I/C	Tp	Unspecified; occurs in caves around the country	Dew (1963); Hamilton-Smith (1967) citing B. Moore (pers. comm); whereabouts

						unknown
Family Pselaphidae						
Tyromorphus speciosus (King, 1865)		N	Tp		Cave in Southern Limestone	Hamilton-Smith (1966); SAMA (BS0624); further material in BP Moore collection now probably within ANIC
Undetermined Pselaphidae					Chifley, Orient, Elder, Mammoth Hennings, Serpentine (damp wall, mud/flood debris, litter Tullgren)	Gibian et al. (1988); whereabouts unknown, probably AMS
CLASS CHILOPODA						
Order Geophilomorpha						
Family Geophilidae						
Undetermined centipede		N?	Ac?		Hennings	Gibian et al. (1988); specimen not traced (photograph in cave only)
CLASS DIPLOPODA						
Order Polydesmida						
Undetermined polydesmids	CC GM	N			Serpentine, Mammoth (Sand Passage, Horseshoe Cavern), Elder	Gibian et al. (1988); AMS (KS.96021, KS.96025, KS.96031, KS.96033, KS.96035-36, KS.102761-62)
Family Dalodesmidae						
Undetermined dalodesmids	RM CC	N	Tp		Devil's Coach House, Hennings (entrance chamber), Serpentine, Mammoth (Sand Passage, Horseshoe Cavern)	Gibian et al. (1988); material collected by Smith, Wheeler, Gibian, Eberhard, in AMS (KS.96009, KS.96022-23, KS.96026-27, KS.96029, KS.96032, KS.96034, KS.96038, KS.106995)
CLASS ARACHNIDA						
Order Araneae						
Family Cycloctenidae						
Cycloctenus abyssinus Urquhart, 1890	MG	N	Tp	Described by Urquhart (1890) from the Jenolan Caves (females). Male described by Rainbow (1893) - not located in AMS collection	Paradox, Mammoth, Hennings (bat guano or wandering over rocks, often in entrance chamber)	Gray (1973); Gibian et al. (1988); material collected by Smith, Holland, Eberhard, Marx and Wheeler in AMS (KS.10222, KS.18274, KS.21855, KS.23495, KS.35009)
Family Desidae						

Badumna socialis (Rainbow, 1905)	Typ	N	Tp	Originally described by Rainbow (1905) as *Amaurobius socialis*; eventually transferred to *Badumna* Gray (1983)	Grand Arch	Types in AMS (KS.6422, KS.6423)
Forsterina sp.	MG	N	Tp		Arch, Serpentine (flood debris)	Gibian et al. (1988); material collected by Smith and Gray in AMS (KS.17834, KS.19041)
Toxopsoides sp.	MG HS	N	Ac		Mammoth entrance chamber	Single specimen collected by Marx in AMS (KS.10223)
Family Dictynidae						
Undetermined				Referred to in Gibian et al. (1988) as "*Callevophthalmus*" group	Devil's Coach House (flood debris)	Gibian et al. (1988); specimen could not be traced
Family Gradungulidae						
Kaiya terama Gray, 1987	MG	N	Tp	First recorded as *Gradungula* sp.n. (Gray 1973), later described (Forster, Platnick and Gray 1987) from material collected in rotting log in forest at Jenolan, and other forest locations in NSW	Paradox, Mammoth, Hennings (twilight zone, tree root chamber)	Gray (1973); Gibian et al. (1988); material collected by Gibian and Eberhard AMS (KS.17844, KS.17846, KS.37485)
Family Lamponidae						
Lampona cylindrata (Koch, 1866)	MG	N	Ac		Grand Arch	Specimens collected by Wood in AMS (KS.6441)
Family Linyphiidae						
Laetesia weburdi (Urquhart, 1890)	MG	N	Tp	Originally described as *Linyphia weburdi* by Urquhart in 1890 from "a cave in NSW", it was later transferred to *Bathyphantes* by Rainbow (1911). Van Helsdingen (1972) transfers the species to *Laetesia*	Chifley, Devil's Coach House, Serpentine (flood debris), Orient; also other NSW caves	Gray (1973); Gibian et al. (1988); Thurgate et al. (2001a); specimens collected by Gray, Smith, Wheeler, Greenslade, Eberhard, Gibian, H. Smith and Musser in AMS (KS.5076, KS.17825, KS.18428, KS.19020, KS.19040, KS.19042, KS.35013, KS.120145)
Ostearius melanopygius (O. P. Cambridge, 1879)		I/C	Ac?			Gibian et al. (1988); not located: most AMS linyphiid material is currently unavailable
n. gen. et n.sp.	MG	N	Tb	Male and juvenile	Imperial, River (moist active shawl)	Gray (1973); Gibian et al. (1988); Thurgate

						et al. (2001a); AMS (KS.115960)
Family Lycosidae						
Lycosa sp.		N?	Ac	Juvenile only	Bow Cave (Tullgren funnel extraction of leaf litter)	Specimen collected by Smith, Wheeler and Gibian AMS (KS.32229)
Family Micropholcommatidae						
Micropholcomma longissimum (Butler, 1932)	GM	N	Ac	Single male; if correctly identified, is probably not Tp; Rix and Harvey (2010) report similar undescribed species from NSW	Imperial (mud bank)	Specimen collected by Smith and Wheeler in AMS (KS.32232)
Micropholcomma sp.	GM	N	Tp?	Male, females and juveniles	Chifley (small irregular webs on stalagmites), Serpentine	Gibian et al. (1988); material collected by Gray and Greenslade in AMS (KS.5075, KS.9969, KS.18429, KS.19043, KS.21854, KS.21853)
Rayforstia sp.	MR	N	Tp?		Mammoth Cave (Horseshoe Cavern) (flood debris, Tullgren funnel)	Single specimen collected by Wheeler, Smith and Gibian in AMS (KS.19030)
Textricella sp.	MR	N	Tp?	Juveniles only	Devil's Coach House (leaf litter berlesate)	Specimens collected by Smith and Wheeler in AMS (KS.19036)
Family Mimetidae						
Australomimetus maculosus (Rainbow, 1904)	Typ	N	Ac	*Mimetus maculosus* was described by Rainbow (1904) from material labelled as Jenolan Caves, collected by J. Wiburd. It was transferred to *Australomimetus* by Heimer (1986) and redescribed by Harms and Harvey (2009)	Imperial (mud bank), Binoomea Cut	Types AMS (KS.5821). Later specimens listed here not identified to species: Gray (1973); Gray one juvenile (KS.17832); Gray, H Smith and Musser one female (KS.120146)
Family Mysmenidae						
Undetermined	MG	N	Ac		Lucas (small web off track)	Gibian et al. (1988), Smith and Wheeler collected a male now in AMS (KS.19046)
Family Orsolobidae						
Tasmanoonops sp.	MG	N	Ac	Females only	Elder (under stone near scattered webs in drip zone below tree roots), Hennings (on pool in intermittent sump area)	Gibian et al. (1988). Material collected by Smith and Wheeler in AMS (KS.18272, KS.19022)
Family Sparassidae						

Heteropoda sp.	HS	N	Ac		Binoomea Cut	Gray, H. Smith and Musser collected female (KS.120153)
Family Stiphidiidae						
Stiphidion facetum Simon, 1902	MG	N	Tp		Mammoth, Arch, McKeowns Hole. Common cave entrance spider but also surface habitats. Also known from caves at Wombeyan, Bungonia, Colong, Yarrangabilly, Wee Jasper, Mole Creek	Gray (1973); Gibian et al. (1988); Eberhard (1993); 3 specimens collected by Smith, Gray and Gibian in AMS (KS.17833, KS.17847, KS.32231)
Family Tetragnathidae						
Orsinome sp.	MG	?	Ac		Bow (in or near webs about 10 m from entrance above litter)	Gibian et al. (1988); specimen collected by Smith in AMS (KS.19045)
Family Theridiidae						
'Achaearanea' sp.	MG		Ac	Undetermined male, females and juveniles; 2 spp, fully pigmented and most likely accidental	Arch, Lucas (web next to track), Elder	Gibian et al. (1988); Eberhard (1993); Specimens collected by Gibian and Gray in AMS (KS.17835, KS.19023, KS.21862)
'Achaearanea' propera (Keyserling, 1890)	HS	N	Ac		Binoomea Cut	Gray, H Smith and Musser collected female (KS.120150)
Cryptachaea gigantipes (Keyserling, 1890)	HS	N	Tp	Previously listed as *Achaearanea veruculata* but species moved to *Cryptachaea* in 2008; however all located specimens have been re-identified as *C. gigantipes* (Keyserling, 1890)	Devil's Coach House (leaf litter berlesate), Chifley (entrance passage)	Gibian et al. (1988); specimens collected by Smith and Wheeler and Gray in AMS (KS.17828, KS.19037-38)
Enoplognatha sp.		N?	Ac?	Doubtful record		Gibian et al. (1988); specimen not traced, may have been re-examined and included with *Icona* sp. or undetermined Theridiidae
Icona n. sp.	HL	N	Tp	Referred to genus *Steatoda* in Gray (1973); subsequently listed under *Icona* (H.W. Levi pers. com. to MG) as sp. 1 and sp. 2 (in Eberhard and Spate 1995, Gibian et al. 1988); likely to represent one variable species	Devil's Coach House, Imperial, Wiburds Lake, Mammoth ("scatty webs over mud or leaf litter")	Gibian et al. (1988); Thurgate et al. (2001a); specimens collected by Smith, Wheeler, Gray, Gibian, Eberhard, Marx; all in AMS (KS.10224, KS.17831, KS.17842, KS.17845, KS.17848, KS.17849, KS.19019, KS.19024-28, KS.19031, KS.19039, KS.32230, KS.35010-12)

Gen.undet. n. sp.?	MG	N	Tb	Listed under *Icona* sp 3 (in Eberhard and Spate 1995, Gibian et al. 1988); very small, fully depigmented, eyeless; known only from single immature male	Hennings (on pool in intermittent sump area)	Gibian et al. (1988); specimen collected by Gray in AMS (KS.18273)
Undetermined		N?	Tp?	Male, females, juveniles	Mammoth (Sand Passage and Horseshoe Cavern) (leaf litter)	Gibian et al. (1988); specimens collected by Gray in AMS (KS.102763, KS.102764)
Family Theridiosomatidae						
Baalzebub sp.	MG	N	Tp	Females and juveniles. Referred to in Gray (1973) as Theridisomatid gen. nov. sp. nov.	Chifley, Elder, Paradox, Hennings, Serpentine, Casteret; usually areas with light breezes; common cave frequenting genus but also found in sheltered surface localities	Gibian et al. (1988); material collected by Gray, Holland, Smith, Gibian, Eberhard, Renwick, Wheeler in AMS (KS.10444, KS.17827, KS.17841, KS.18275, KS.19021, KS.19044, KS.19047, KS.21856, KS.35008, KS.73233)
Family Uloboridae						
Philoponella pantherina (Keyserling, 1890)	MG	?	Tp?		Chifley, Lucas, Grand Arch	Gray (1973); Gibian et al. (1988); specimens collected by Gray and Gibian in AMS (KS.10227, KS.17826, KS.17836, KS.21861)
Order Opiliones						
Family Triaenonychidae						
Holonuncia cavernicola Forster, 1955	GH MG	N	Tp	Described by Forster (1955b) from material collected at Jenolan Caves. Hamilton-Smith (1967) also listed Yarrangabilly, Wyanbene and Wombeyan as locations for species. Hunt (1992) examines additional material from Jenolan and redescribes the species (and the genus for which *H. cavernicola* is the type species)	Chifley, Imperial, Devil's Coach House, Hennings, Cerberus, McKeowns Hole, a Southern Limestone cave, Temple of Baal, Paradox and several epigean specimens from the Jenolan area; tentatively also a specimen from Tuglow Caves. Pigmentation and eye mound size varies between cave and surface populations	Hunt (1992); Forster (1955b), types in AMS (KS.6912, KS.6914); Gibian et al. (1988) other material collected by Hunt, Gray, Clark, Gibian, Eberhard, Smith, Wheeler, Dew, Guides and "Speleo Club" in AMS (KS.5077, KS.17829, KS.19033, KS.19048, KS.19050, KS.21402-04, KS.21857, KS.23216, KS.35027)
Family Neopilionidae						
Megalopsalis sp.	GH MG	N	Ac	Listed as *Spinicrus* by Gibian et al. (1988); genus is now considered to	Mammoth	Gibian et al. (1988) specimens collected by Pickering and Gibian in AMS (KS.19032,

				be part of *Megalopsalis*		KS.97658)
Acarina						
Order Mesostigmata						
Family Ascidae						
Proctolaelaps holmi Halliday, 2001	BH	N	Tp	Described from material collected by E. Holm at Jenolan	Lucas (bat guano)	Halliday (2001); 10♀♀; types in ANIC
Proctolaelaps pygmaeus (Müller, 1859)	BH	I/C	Tp?	Cosmopolitan species described from a cave in Germany	Lucas (bat guano)	Halliday (2001); 4♀♀ ANIC
Family Digamasellidae						
Dendrolaelaps adelaideae Womersley, 1954	BH	N	Ac		Devil's Coach House (overflow passage) (litter), Serpentine (litter), Paradox (guano)	Halliday (2001); 4♀♀ 2 DN; ANIC
Family Laelapidae						
Stratiolaelaps scimitus (Womersley, 1956)	BH	N	Tp?	Originally identified in Halliday (2001) as *Stratiolaeleps miles* (Berlese, 1892) which was thought to be the same as *S. scimitus*; they are now known to be different species (Halliday in litt. 2013)	Lucas (guano); soil dwelling predatory mite	Halliday (2001); 11♀♀ 4DN 2PN (laboratory reared progeny); ANIC
Several species of *Gaeolaelaps* Evans and Till, 1966	BH			This family very difficult taxonomically so further identification of these species still required (Halliday in litt. 2013)		Halliday (in litt. 2013); ANIC
Family Macrochelidae						
Geholaspis mandibularis (Berlese, 1904)	BH	I/C	Ac		Devil's Coach House (overflow passage), Serpentine, Bow, Mammoth (Horseshoe Cavern, Sand Passage) (litter); previously only recorded from Europe where it is widespread and abundant	Halliday (2001); 25 ♀♀ 14DN 8PN; ANIC
Macrocheles tenuirostris Krantz and Filipponi, 1964	BH	N	Tp		Paradox (guano); subterranean species found in caves and animal burrows in SE Australia	Halliday (2001); 1♀; ANIC
Family Ologamasidae						

Antennolaelaps testudo Lee, 1970	BH	N	Ac		Bow; known from Queensland (moss and leaf litter)	Halliday (2001); 1♀; ANIC
Athiasella caverna Halliday, 2001	BH	N	Tp	Described from material collected by Eberhard as well as Gibian, Smith and Wheeler	Devil's Coach House (overflow passage), Serpentine, Bow (litter), also surface localities at Jenolan	Halliday (2001); 8♀♀; types in ANIC
Geogamasus fornix Halliday, 2001	BH	N	Tp	Described from material collected by Gibian, Smith and Wheeler	Bow (litter)	Halliday (2001); 2♀♀; types in ANIC
Family Pachylaelapidae						
Pachydellus hades Halliday, 2001	BH	I/C	Ac	Described as *Pachylaelaps hades* by Halliday (2001) from material collected by Smith and Wheeler and subsequently transferred to *Pachydellus* (Mašan 2007). Later (Halliday and Mašan 2008) found to be a species common in south-eastern Europe but not previously described due to its similarity with other species. It is therefore probably introduced into Australia	Devil's Coach House (overflow passage) (litter)	Halliday (2001); 3♀♀; types in ANIC
Pachylaelaps humeralis Berlese, 1910	BH	I/C	Ac		Devil's Coach House (overflow passage), Mammoth (Horseshoe Cavern); Bow (litter)	Halliday (2001); 31♀♀ 1 DN; ANIC
Family Parasitidae						
Pergamasus quisquillarum (Canestrini and Canestrini, 1882)	BH	I/C	Ac		Mammoth (Horseshoe Cavern), Devil's Coach House (overflow passage), Bow (litter) as well as surface localities at Jenolan. Widespread in Europe, occurring in decomposing organic matter including leaf litter	Halliday (2001); 23♀♀ 3♂♂ 3DN; ANIC
Family Veigaiidae						
Veigaia pusilla (Berlese, 1916)	BH	I/C	Ac		Devil's Coach House (overflow passage) (litter), Mammoth (Horseshoe Cavern and Sand Passage) (litter), Serpentine (litter), Bow (litter). Known in Europe and North America from soil and dead leaves	Halliday (2001); 24♀♀ 2DN; ANIC

Veigaia planicola (Berlese, 1892)	BH	I/C	Ac	Identified as *Veigaia serrata* Willman, 1935 in Halliday (2001) which has recently been shown to be a synonym of *Veigaia planicola*; very common European species (Halliday in litt. 2013)	Devil's Coach House, Mammoth (Horseshoe Cavern and Sand Passage), Serpentine, Bow (litter)	Halliday (2001); 20♀♀ 12DN; ANIC
Infraorder Uropodina						
Family Trachytidae						
Acroseius tuberculatus (Womersley, 1961)	BH	N	Ac		Bow; common in leaf litter in NSW forests	(Halliday in litt. 2013); ANIC
Apionoseius n.sp.	BH	N	Tp		Abundant in Mammoth (Horseshoe Cavern), Devil's Coach House, Bow, Paradox; also present in other caves in NSW	(Halliday in litt. 2013); ANIC
Polyaspinus tasmanicus Bloszyk and Halliday, 2000	BH	N	Tp		Paradox; described from forest litter in Tasmania; also present in Deua Caves	(Halliday in litt. 2013); ANIC
Family Uropodidae						
n. gen. et n.sp.	BH	N	Tp?		Mammoth (Horseshoe Cavern) (flood debris)	(Halliday in litt. 2013); ANIC
Family Urodinychidae						
Castriidinychus n. sp.	BH	N	Tp?		Serpentine, Mammoth (Horseshoe Cavern), Paradox, Devil's Coach House (guano, flood debris). Genus described for three species found in leaf litter	(Halliday in litt. 2013); ANIC
Uroobovella coprophila (Womersley, 1960)	BH	N	Tp		Present in many cave systems, very abundant in guano in Jenolan and Wee Jasper	(Halliday in litt. 2013); ANIC
Family Polyaspididae						
Uroseius n.sp.	BH	N	Tp		Paradox (guano), Bow; also occurs in guano at Deua Caves and Wee Jasper	(Halliday in litt. 2013); ANIC
Family Dinychidae						
Dinychus greensladeae Bloszyk and Halliday, 1995	BH	N	Ac		Described from forest litter in Tasmania, now found to be abundant in all Jenolan	(Halliday in litt. 2013); ANIC

					flood debris samples	
Order Trombidiformes suborder Prostigmata						
Family Rhagidiidae						
Undetermined	BH	?	?		Found in low numbers in various caves at Jenolan; predatory mites	(Halliday in litt. 2013); ANIC
Family Erythraeidae						
Undetermined	BH	?	?		Found in low numbers in various caves at Jenolan; predatory mites	(Halliday in litt. 2013); ANIC
Family Pygmephoridae						
Undetermined	BH	?	?		Found in low numbers in various caves at Jenolan; fungivorous mites	(Halliday in litt. 2013); ANIC
Order Sarcoptiformes						
Undetermined Oribatida	BH		Tp		Present in most samples, sometimes abundant	(Halliday in litt. 2013); ANIC
Order Ixodida						
Family Ixodidae						
Bothriocroton undatum (Fabricius, 1775)		N	Ac	Originally described as *Acarus undatus* (Fabricius, 1775), later included under *Aponomma* and finally transferred to *Bothriocroton*	Paradox (Tullgren funnel samples of bat guano); a parasite of reptiles	Specimen collected from guano by Smith and Holland in AMS (KS.21858)
Order Pseudoscorpiones						
Family Chthoniidae						
Austrochthonius sp.	MH	N	Ac?		Devil's Coach House (leaf litter, berlesate)	Gibian et al. (1988); material collected by Smith and Wheeler in AMS (KS.19034-35)
Sathrochthonius tuena Chamberlin, 1962	MG MB	N	Tp	Described by Chamberlin (1962) from material labelled "unnamed cave, 'probably in the Blue Mountains near Sydney'". Beier (1967) confirms species present at Jenolan	Southern Limestone; Paradox (Tullgren funnel); also known from Wombeyan Caves	Beier (1967), Gibian et al. (1988); material collected by Holland, Smith, Gibian, Wheeler, Dew in AMS (KS.21859-60, KS.32228, KS.88165-66); ♂ holotype (JC-2014.02001, ♀ allotype (JC-2014.0202) in AMNH
Family Pseudotyrannochthoniidae						

Pseudotyrannochthonius jonesi (Chamberlin, 1962)	MG MH	N	Tb	Originally described as *Tubbichthonius jonesi* Chamberlin, 1962 from material labelled "cave in Australia, 'probably in Blue Mountains near Sydney'". Transferred by Beier (1966) to *Pseudotyrannochthonius*. Redescribed Harms and Harvey (2013)	Imperial, Chevalier extension	Chamberlin (1962), Gibian et al. (1988); Harms and Harvey (2013); material collected by Gray and "Speleo club" in AMS (KS.5279, KS.17267, KS.17830, KS.21863); ♀ holotype (JC-2014.01001) in AMNH
PHYLUM MOLLUSCA						
Undetermined Gastropoda					Hennings, Serpentine, Mammoth, Wiburds Lake	Gibian et al. (1988); whereabouts unknown possibly AMS
Family Camaenidae						
Pommerhelix depressa (Hedley, 1901)	CA	N	Tp	Described from Jenolan Caves as *Thersites gulosa depressa*, later referred to as *Meridolum depressum* and included in *Pommerhelix* by Clark (2009)	Casteret	Dew (1963); AMS (C.325073)
Family Charopidae						
Elsothera sericatula (Pfeiffer, 1849)	JS	N	Ac	Listed in Dew (1963) as *Strongesta* sp. but only specimen in AMS collected by Dew in Southern Limestone has since been identified as *Elsothera sericatula* (Pfeiffer, 1849)	Cave in Southern Limestone	Dew (1963); AMS (C.354880)
Family Glacidorbidae						
Glacidorbis hedleyi Iredale, 1943	WP	N	Ac		Imperial resurgence	AMS (C.361944)
SUBPHYLUM CRUSTACEA						
Order Cyclopoida						
Undetermined					Imperial river (netted)	Gibian et al. (1988); material collected by Smith and Wheeler in AMS (P.38508)
Family Cyclopidae						
Macrocyclops albidus	TK	I/C	Ac		Mammoth (muddy pools left after Lower	Eberhard (1993); Thurgate et al. (2001b);

(Jurine, 1820)					River flood); widely distributed larvivorous species	material collected by Eberhard in AMS (P.65478, P.65478.001)
Tropocyclops prasinus (Fischer, 1860)	TK	I/C	Ac		Lucas; widely distributed species	Eberhard (1993); Thurgate et al. (2001b); material collected by Eberhard in AMS (P.65479, P.65479.001)
Order Amphipoda						
Family Eusiridae						
Pseudomoera fontana (Sayce, 1902)	JB	N	Ac?	Originally described as *Atyloides fontana* from stream at Woods Point (Vic); moved to *Pseudomoera* by Barnard and Karaman (1982)	Northern Streamsink, Imperial resurgence; SE Australian species inhabiting freshwater streams	Eberhard (1993); material collected by Eberhard in AMS (P.82630-31)
Family Neoniphargidae						
Neocrypta simoni Bradbury and Williams, 1997	JB WW	N	Sb	Described by Bradbury and Williams (1997) from Paradox Cave	Paradox	Eberhard (1993); Thurgate et al. (2001b); holotype and allotype collected by Eberhard in AMS (P.51368-69)
Undetermined					Imperial river	Gibian et al. (1988); Eberhard (1993); Thurgate et al. (2001b); 5 specimens netted by Smith, Gibian and Wheeler in AMS (P.38506)
Order Anaspidacea						
Undetermined	PS	N			Spider (flood pool); River (Pool of Reflections)	Eberhard (1993); Thurgate et al. (2001b); material collected by Eberhard and Thurgate in AMS (P.45752, P.57897)
Family Psammaspididae						
n. gen. et n.sp	PS	N	Sb		Spider (flood pool), Imperial and Jubilee (river and flood pools)	Eberhard (1993); Thurgate et al. (2001b); material collected by Eberhard in AMS (P.43374, P.45764-65)
Order Isopoda						
Large pigmented eyed oniscid slater			Ac		Elder	Gibian et al. (1988); specimen not traced
Family Phreatoicidae						
Crenoicus sp.	GW	N	Sp?		Imperial resurgence, Paradox	Eberhard (1993); Thurgate et al. (2001b); material collected by Eberhard in AMS

					(P.52680-81)
Family Styloniscidae					
Styloniscus sp.	AG	N	Tp?	Mammoth (Cold Hole) (gravel, mud)	Gibian et al. (1988); Eberhard (1993); Thurgate et al. (2001b); material collected by Smith in AMS (P.38507)
PHYLUM ANNELIDA					
Subclass Oligochaeta					
Undetermined terrestrial and aquatic worms		?	?	Devil's Coach House, Imperial river, Mammoth, Serpentine, Cerberus, River	Gibian et al. (1988); Eberhard (1993); Eberhard and Spate (1995); location of specimens unknown
PHYLUM NEMATODA					
Undetermined terrestrial and aquatic nematodes?		?	?	Devil's Coach House, Imperial river, Mammoth, Serpentine, Cerberus, River	Gibian et al. (1988); Eberhard (1993); location of specimens unknown
PHYLUM PLATYHELMINTHES					
Undetermined flatworms of both Paludicola and Terricola		?	?	One flatworm possibly troglobitic (Eberhard and Spate, 1995)	Dew (1963); Eberhard (1993); Eberhard and Spate (1995); Thurgate et al. (2001a); Moulds (in litt. 2013); location of specimens probably AMS